5.0
Status and Trends for Mercury, DDT, PCBs, and PBDEs

The contaminants discussed in this report—mercury, DDT, PCBs, and PBDEs—come from a variety of sources and can potentially result in health concerns for wildlife or people. Table 5.1 summarizes the sources and health concerns of these four contaminants.

In order to evaluate whether the toxics reduction efforts currently under way in the Basin are having an impact or if other activities are needed, it is important to understand whether the levels of contaminants are increasing or decreasing over time. While considerable information has been collected over the past 20 years, the data are limited with regard to whether the contaminants are increasing or decreasing Basin-wide. There is some trend information for specific areas of the Basin such as the Lower Columbia. While not comprehensive, this report highlights trend data when such data are available.

Table 5.1: Contaminants of concern summary

Contaminant	Sources/Pathways	Concern
Mercury	Atmospheric deposition from sources inside and outside the region is thought to be a major pathway for mercury. Other possible sources/pathways include releases from past and current mining and smelting activities; erosion of native soils; agricultural activities; discharge of wastewater and stormwater; and resuspension and recirculation of sediments.	Mercury can cause neurological, developmental, and reproductive problems in people and animals.
DDT	DDT was banned in the United States in 1972, but DDT and its breakdown products are still found in the environment in sediments and soil. The main pathway to the River is via runoff from agricultural land.	DDT thins bird eggshells and causes reproductive and development problems. It is linked to cancer, liver disease, and hormone disruption in laboratory-test animals.
PCBs	PCBs were banned in the United States in 1976, but they are still widely found in the environment in fish tissue and sediments. Industrial spills and improper disposal are known sources locally, while incineration and atmospheric deposition bring PCBs from distant sources. Stormwater runoff and erosion may also be important pathways.	PCBs can harm immune systems, reproduction, and development; increase the risk of cancer; and disrupt hormone systems in both people and aquatic life.
PBDEs	PBDE flame retardants are present in many consumer products, including electronics, textiles, and plastics. There is limited information on the transport pathways to the River, but some possible pathways include atmospheric deposition, municipal and industrial wastewater, stormwater discharge, and runoff.	PBDEs accumulate in the environment, harming mammals' reproduction, development, and neurological systems. They can increase the risk of cancer and disrupt hormone systems.

VISIT THE WEB Additional information and updates about mercury, DDT, PCBs, and PBDEs can be found by visiting EPA's Columbia River website: http://www.epa.gov/region10/columbia.

Mercury: Most Fish Consumption Advisories in the Basin are due to High Concentrations of Mercury

Mercury can affect the nervous system and brain, and even low doses can impair the physical and mental development of human fetuses and infants exposed via the mother's diet. Fish consumption advisories generally discourage the consumption of larger fish and predatory fish, as they typically contain higher concentrations of mercury. Figure 5.1 shows mercury concentrations found in fish from U.S. waters in the Columbia River Basin.

As a metallic element, mercury is never destroyed, but cycles between a number of chemical and physical forms. Mercury in the aquatic environment can be converted by bacteria to a more toxic form, called methylmercury. This process is important because methylmercury can biomagnify, so predators at the top of the food web will have much higher concentrations of mercury in their bodies than are found in the surrounding water or the algae and insects at the base of the food web.

Methylmercury is the dominant form of mercury found in fish, and the concentrations of methylmercury found in fish are directly related to the amount available in the aquatic environment. The rate at which methylation of mercury occurs varies according to water body characteristics such as the amount of organic matter, sulfate, and iron present and the acidity, temperature, and water velocity.

Several pathways introduce mercury into the Columbia River Basin

Mercury enters the Columbia River and its tributaries via several pathways, including atmospheric deposition, runoff, wastewater discharges, industrial discharges, and mines. Based on available data, atmospheric deposition appears to be the major pathway for mercury loading to the Columbia River Basin. [1] Mercury air deposition includes both emissions from industrial facilities within and near the Basin and fallout from the pool of global mercury that has been transported from sources as far away as Asia and Europe.

EPA estimates that the total mercury air deposition in the Columbia River Basin is 11,500 pounds per year. [2] Approximately 84 percent of that load comes from global sources. At a watershed scale, however, local and regional sources can contribute the majority of mercury deposited on the local landscape. For example, a cement plant in Durkee, Oregon, emits more than 2,500 pounds of mercury per year. [3] Although just over 140 pounds of this amount are deposited in the sub-basin in which this plant is located, that deposition constitutes an estimated 62 percent of the air-deposited load in that area. [4]

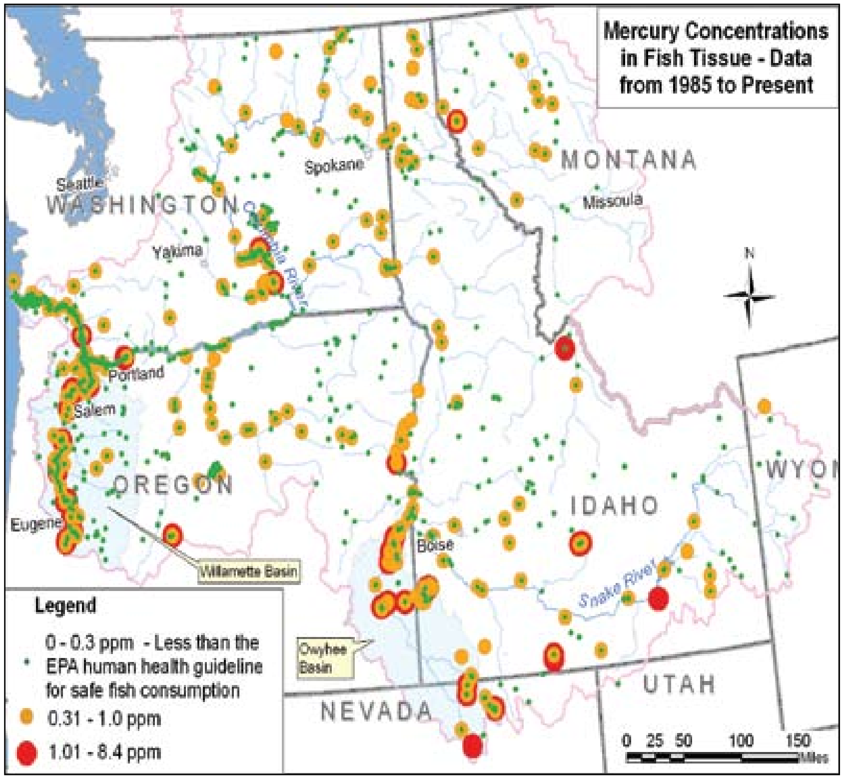


Figure 5.1: Seventy-five percent of fish consumption advisories in the Columbia River Basin are due to mercury contamination. In the fish tested, high levels of mercury have been consistently found downstream of historic mining areas in the Willamette and Owyhee River Basins. There is no information about mercury levels in fish from waters that are unmarked on the map.

As for regional sources, in northern Nevada near the Basin's southeast boundary, several gold mines emit mercury from their ore roasters. One of these mines discharges more than 1,700 pounds of mercury per year. [3] Although only part of this load ends up in the Columbia River Basin, almost 160 pounds are deposited in the nearby Upper Owyhee watershed in Idaho, accounting for 58 percent of the atmospheric mercury loading there. [4] In Idaho, the largest source of mercury emissions is an elemental phosphorus plant in Soda Springs. This plant emits more than 900 pounds per year [3] and contributes 36 percent of the mercury deposited in the adjacent watershed. [4]

Across the United States, coal-fired power plants are a major local source, but they are less significant sources in the Northwest because so few are located here. There is a single coal-fired power plant in the Columbia River Basin located near Boardman, in eastern Oregon. This plant emits about 168 pounds of mercury per year. [3] There are also three coal-fired power plants near the boundary of the Basin (one in Washington and two in Nevada) that could contribute some mercury load to the watershed, depending upon their emissions and prevailing wind patterns.

Not all of the mercury that falls onto land gets transported to water bodies. Forests and other undisturbed landscapes can retain mercury for years.

Other point sources directly discharge mercury to rivers and streams. Wastewater treatment plants, industrial discharges, and stormwater runoff from streets and other developed areas are more direct sources of mercury to streams than air deposition or erosion. These sources may be low in concentration, but high in volume. Nine of the 23 largest municipal and industrial wastewater point sources located in the U.S. portion of the Columbia River have reported discharging a total of 33 pounds of mercury per year. [5] This may be an underestimate, however, because mercury reporting is not always required and mercury detection limits are often too high to provide useful information. Although these sources contribute less mercury to the basin than the air pathway, they may be significant at a local scale because they discharge directly to water bodies. A smelter just north of the Canadian border directly discharged an average of 184 pounds of mercury per year to the Upper Columbia from 1994 through 1998. This load was reduced to an average of 38 pounds of mercury per year for the 1999-2007 time period. [6] Historic mercury and gold mining can also be important sources that load mercury directly to streams and have significant impacts at a watershed scale.

Mercury is also still found in several commonly used products such as fluorescent light tubes, compact fluorescent lamps, thermometers, thermostats, switches in vehicles, some batteries and pumps, and medical equipment such as blood pressure measuring devices. Although mercury has been or will be removed from some of these products, many of the older versions still contain mercury. If these older products are not handled and disposed of properly, they can add mercury to the environment.

Regional trends and spatial patterns of mercury levels in the Basin can be difficult to evaluate

Although data on mercury concentrations are available for resident fish species in the Basin from the 1960s to the present, there are few locations with consistent, comparable data from different time periods that can be used to evaluate changes in mercury concentrations over time. Two exceptions, noted in Figure 5.2, are mercury concentrations in northern pikeminnow from the Willamette River Basin and mercury concentrations in osprey eggs in the Lower Columbia River, both of which have been increasing in the last decade. [7,8,9] The osprey egg concentrations, however, were still below levels that are of concern in birds. Another study shows that mercury concentrations increased in pikeminnows (1.12 to 1.91 parts per million [ppm]) from the Upper Willamette River between 1993 and 2001. [10]

The Columbia River sturgeon population living in the pool behind Bonneville Dam has much higher concentrations of mercury in their livers than sturgeon in the estuary or other Columbia River reservoir pools. Sturgeon tissues from the Kootenai, Upper Columbia, and Snake Rivers contained mercury concentrations in the range of 0.02 to 0.6 ppm, but Bonneville pool sturgeon have mean concentrations of 4 ppm. [11,12,13,14] Also, high mercury levels in liver and other organs from Lower Columbia River white sturgeon are correlated with lower physical health indices and reproductive defects in the fish. [15,16,17,18,19]

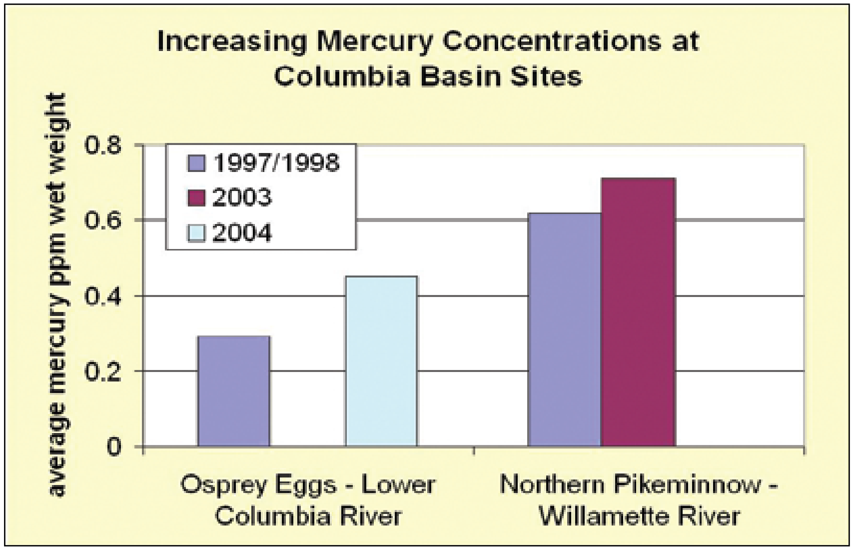


Figure 5.2: Mercury levels in Willamette River northern pikeminnow and Lower Columbia River osprey eggs have increased over the last decade. Mercury level trends have not been studied in other Columbia River Basin organisms over the

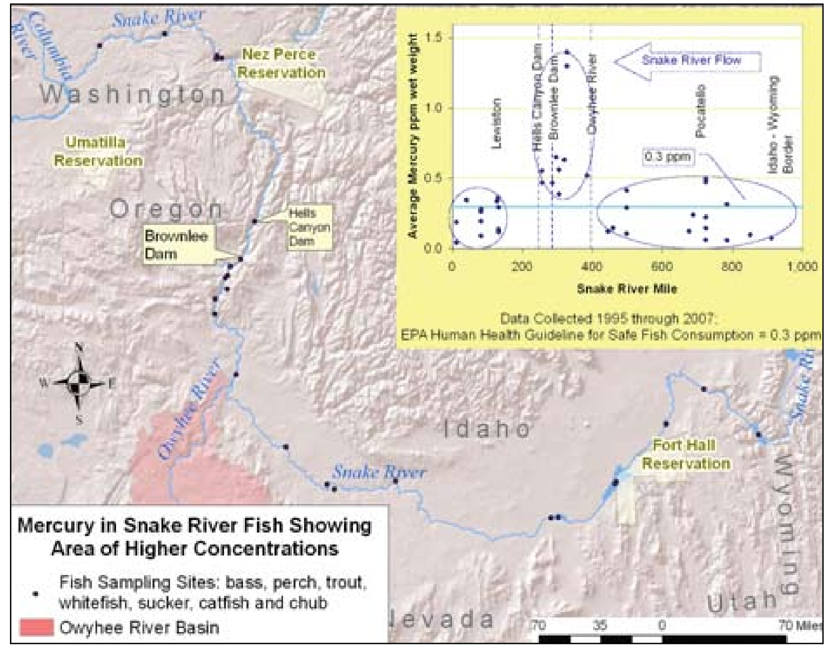


Figure 5.3: Mercury levels are highest in fish collected at Brownlee Dam reservoir, downstream from the Owyhee River inflow. The Owyhee River is contaminated by mercury from historic mining.

Mercury concentrations vary across the basin, but only in some cases are the sources known. For example, in reservoirs in the Owyhee River basin [20,21] and in the Snake River downstream of the Owyhee confluence, mercury levels are found above EPA's 0.3-ppm mercury human health guideline due to mercury used in gold mining there in the 1800s (Figure 5.3). [22,23,24,25,26,27,28,29]

DDT: Banned in 1972, This Pesticide Still Poses a Threat to the Environment

DDT is the most well-known of a class of pesticides that were widely used from the 1940s until EPA banned them in the United States in 1972. However, DDT continues to be used in other parts of the world. DDT and its breakdown products—dichlorophenyldichloroethylene (DDE) and dichlorophenyldichloroethane (DDD)—have been linked to neurological and developmental disorders in birds and other animals. DDT has also been linked to eggshell thinning that caused declines in many bird species and inspired Rachel Carson's 1962 book *Silent Spring*, which documented detrimental effects of pesticides on bird species and ultimately led to the banning of DDT.

The chemical structure of DDT is very stable in the environment, which is why DDT and its breakdown products DDE and DDD continue to be an ecological and human health threat. Figure 5.4 shows DDE concentrations found in fish from U.S. waters in the Columbia River Basin.

Soil erosion from agricultural runoff is the main source of DDT into the Basin

The primary source of DDT to the Columbia River Basin is the considerable acreage of agricultural soils in which DDT accumulated over three decades of intensive use (1940s to early 1970s). DDT reaches the River when the soils are eroded by wind and water. Some irrigation practices increase soil erosion on agricultural lands. Other potential sources of DDT are areas where pesticides were handled or stored, such as barns or agricultural supply sheds, or areas where containers or unused product were disposed. The main pathway for these sources is erosion and runoff. Disturbance of contaminated sediments within the Columbia River and its tributaries may also release DDT to the water column, which can directly or indirectly be taken up by fish.

DDT levels are declining with better soil conservation practices, but DDT still exceeds human health levels of concern

The ban on DDT combined with significant improvements in soil conservation by farmers reduced DDT loading to the Columbia River Basin. [1] A number of state water quality improvement plans currently aim to reduce DDT compounds, and continued monitoring is critical to demonstrating the effectiveness of these actions.

Concentrations of DDT compounds in the Columbia River and its wildlife have decreased over the last 20 years. However, DDT is still regularly detected in the fish, plants, and sediments of the River and many of its tributaries, indicating that DDT continues to cycle through the food web. In addition, fish consumption advisories continue to be issued for DDT in Lake Chelan.

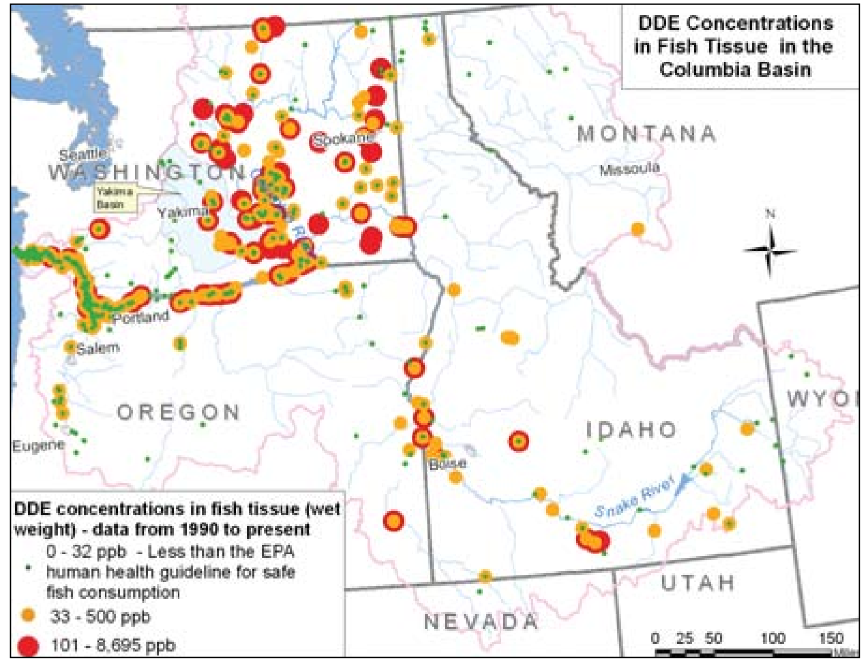


Figure 5.4: High levels of DDE in fish are found in areas where DDT pesticide use was historically high, such as in eastern Washington and the Snake River Plain. There is no information about DDE levels in fish from waters that are unmarked on the map.

DDT levels have declined in several of the key species of resident fish in areas of the Columbia River Basin. DDT contamination has been most intensively studied in the Yakima River, which is a major tributary to the Columbia in Washington State and is in one of the most diverse agricultural areas of the country. [2] Data collected in the 1980s showed that fish in the Yakima River Basin had some of the highest concentrations of DDT in the nation. [3]

In the late 1990s, a partnership of farmers, irrigation districts, the Confederated Tribes and Bands of the Yakama Nation, and many governmental agencies initiated changes in farming and irrigation practices that have dramatically reduced erosion from farmland in the Yakima Basin (see Section 6.0 of this report). Sampling of resident fish conducted between 1996 and 2006 showed an overall decline in DDT levels in several species, including bass and sucker (Figure 5.5). [4,5]

By contrast, liver tissues from Columbia River white sturgeon residing in the pool upstream of Bonneville Dam contained much higher concentrations of DDT than other sub-populations of sturgeon residing in the Columbia River Basin (Figure 5.6). [6,7,8,9,10,11,12,13] The cause of these elevated concentrations is not known.

DDT is also a problem for fish-eating birds such as bald eagles and osprey. Severe declines in eagle populations in the Lower Columbia River occurred from the 1950s to1975. Studies conducted along the Lower Columbia River from 1980 to 1987 found elevated concentrations of DDE in bald eagles. [14] High concentrations of DDE are associated with eggshell thinning and low reproductive success.

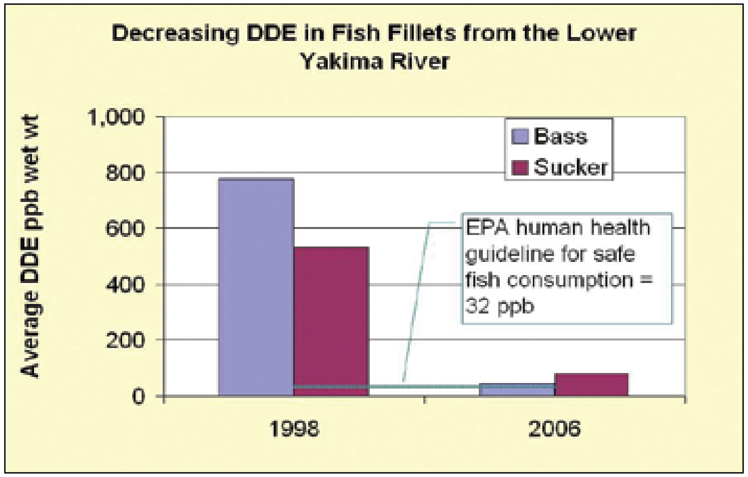


Figure 5.5: DDE levels in Yakima River fish have declined significantly since 1998.

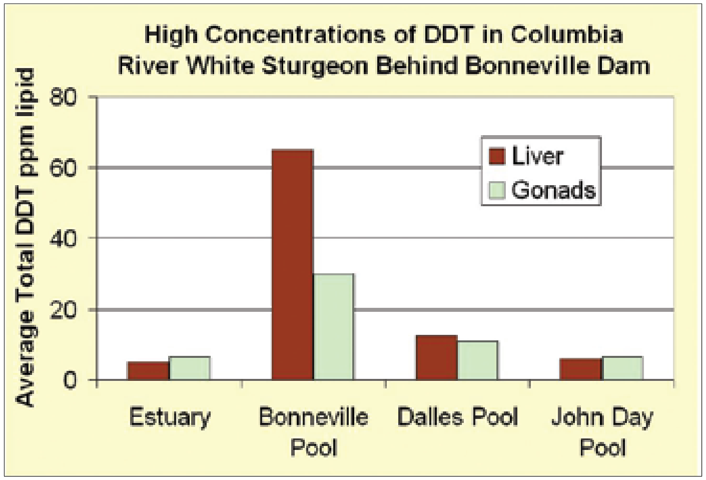


Figure 5.6: Sturgeon in the pool behind Bonneville Dam have much higher levels of DDT and other contaminants (such as mercury and PCBs) than do sturgeon downstream of the dam or sturgeon in pools behind upstream dams.

Successful reproduction of bald eagles along the Columbia River was also found to be considerably lower than the statewide average for Oregon. [15,16] DDE concentrations in Columbia River eagle eggs in the 1980s were the highest recorded for bald eagles in the western United States, surpassed only by levels found in eagle eggs from highly contaminated areas of the eastern United States. [14]

In a similar study in the mid-1990s, researchers found that total DDE concentrations in Columbia River eagle eggs declined significantly in comparison to concentrations found in the mid-1980s (Figure 5.7). [15,16]

Prior to the use of DDT, nesting osprey were common along the Lower Columbia and Willamette Rivers, [17] but populations declined dramatically from the 1950s to the 1970s. As with eagles, DDT was the primary cause of osprey population decline because of eggshell thinning. Figure 5.8 shows the increase in nesting osprey along the Willamette River, an important tributary of the Columbia River, from 1976 to 2001. Similar trends have been found in the Columbia River. A 1976 survey of the 300-mile-long Oregon side of the Columbia River found only one occupied osprey nest. [18,19] In 2004, there were 225 osprey nests in the same area. Scientists recorded a 69 percent decrease in DDT levels in osprey eggs from the Lower Columbia River between 1997 and 2004, coinciding with an increase from 94 to 225 osprey nests. [20]

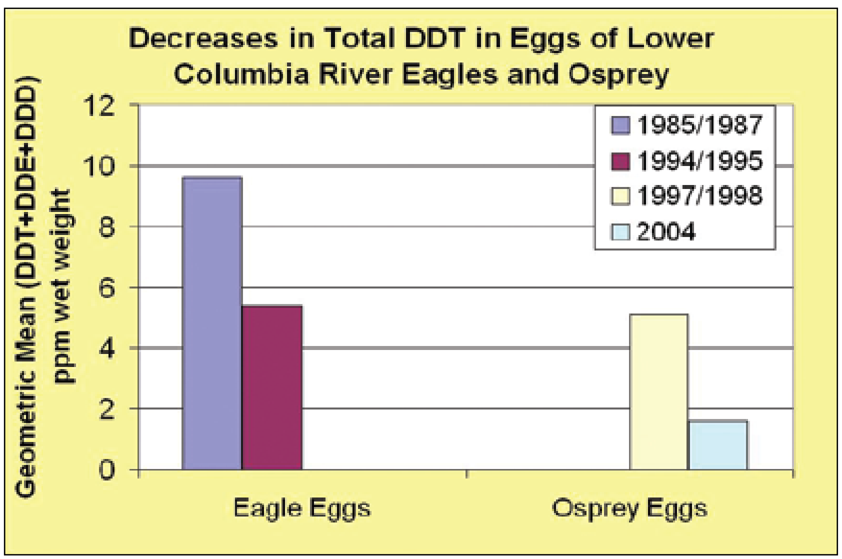
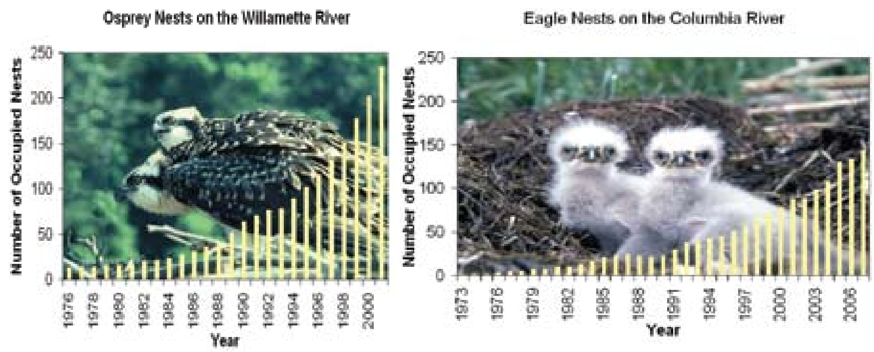


Figure 5.7: DDT levels have decreased significantly in eagle and osprey eggs from the Lower Columbia River over the past 20 years.



(photos courtesy of Peter McGowan, U.S. Fish and Wildlife Service)

Figures 5.8 and 5.9: Nesting pairs of osprey and bald eagle have increased significantly from near-regional extinction in the 1970s, due to reductions of DDT and other contaminants in the environment. [19,21]

Since the late 1970s, the number of bald eagle nesting pairs along the Lower Columbia River also has increased (Figure 5.9). In 2006, there were over 133 nesting pairs of bald eagles, up from 22 in 1980. However, researchers also found that long-established eagle pairs that had been breeding for many years along the Lower Columbia River produced about half the number of young as eagles that had more recently begun nesting there. The greater reproductive success of the newer nesting bald eagle population is attributed in large part to reduced exposure to DDT. [16]

PCBs: Stable PCB Compounds Continue to Persist in the Environment

PCBs are a class of man-made compounds known for their chemical and thermal stability. PCBs were manufactured to take advantage of these properties in such applications as electric transformers and capacitors, heat exchange and hydraulic fluids, lubricants, fluorescent light ballasts, fire retardants, plastics, epoxy paints, and other materials. Before PCBs were banned in the 1970s, approximately 700 million tons of PCBs were produced in the United States, and hundreds of tons remain in service today.

Environmental concentrations of PCBs decrease very slowly because they are stable and persistent. PCBs tend to concentrate in the fatty tissue of fish and other animals and can be passed from mother to young. PCBs have been linked to liver damage, disruption of neuro-development, reproductive problems, and some forms of cancer. PCB levels have triggered fish and shellfish advisories in the Lower Columbia River and several other water bodies in the Basin.

Figure 5.10 shows PCB concentrations found in fish from U.S. waters in the Columbia River Basin.

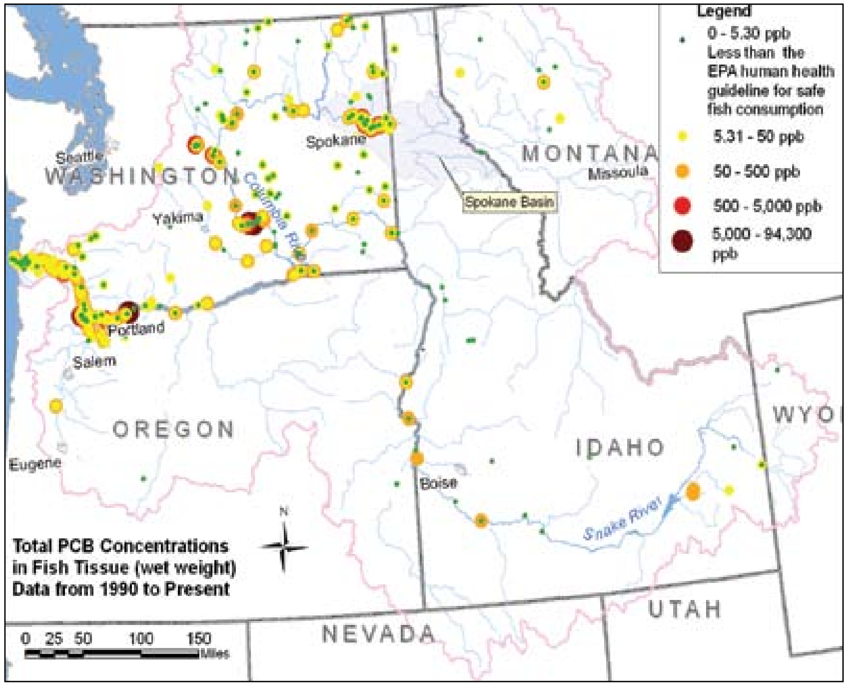


Figure 5.10: A legacy contaminant, PCB hot spots correspond to areas of historic industrial use or disposal sites. There is no information about PCB levels in fish from waters that are unmarked on the map.

PCBs enter the ecosystem from multiple sources and through multiple pathways

PCBs in the Columbia River Basin tend to be associated with industrial locations, where spills or historic handling practices (such as disposing of PCB-contaminated materials in unlined landfills near the River or dumping such materials directly into the River) were more likely to occur. Several examples of known PCB disposal sites in the Lower Columbia River include Bradford Island at Bonneville Dam; Alcoa Smelter in Vancouver, Washington; and Portland Harbor on the Willamette. In addition, historically, many pieces of electrical equipment used to generate power at dams in the Columbia River Basin used cooling and insulating oil that contained PCBs. Past practices such as the use of PCB-laden paint in fish hatcheries and the use of oils tainted with PCBs to control dust on unpaved roads also led to PCB contamination.

Inefficient incineration of PCB-containing materials, followed by atmospheric deposition, is the primary means by which PCBs from other parts of the world reach the Columbia River Basin. Regionally, snowmelt, stormwater runoff and discharge, and soil erosion are pathways by which PCBs deposited on land are transported to water. PCBs entering rivers and streams from stormwater runoff and discharge are a growing concern. PCBs are not very water-soluble, but they do adhere to organic matter and sediment particles, so they have a high potential to be transported when sediment is transported (such as during storms and floods) and then accumulate in pools or reservoirs.

PCBs in fish are declining but still exceed EPA human and ecological health concern levels in some areas

In the early 1990s, the Washington Department of Ecology (WADOE) found high concentrations of PCBs in rainbow trout, mountain whitefish, and large-scale sucker in the Spokane River. [1] The Department took steps to identify and clean up hazardous waste sites and reduce PCB inputs from municipal and industrial wastewater dischargers. As a result, concentrations of PCBs in rainbow trout, mountain whitefish, and sucker have decreased between 1992 and 2005 in almost every reach of the Spokane River (Figure 5.11). [1,2,3,4,5]

As with mercury and DDT, several studies have revealed that Columbia River sturgeon living in the pool behind Bonneville Dam contained much higher concentrations of PCBs in their livers than sturgeon in other areas of the Basin. [6]

Recent studies indicate that juvenile fall Chinook salmon from throughout the Basin are accumulating toxic contaminants, including PCBs, in their tissues. [7,8,9] As shown in Figure 5.12, PCB concentrations in juvenile salmon are higher in out-migrating juveniles sampled in the Lower Columbia River near the confluence of the Willamette River than in juveniles sampled at Warrendale just below the Bonneville Dam. Two studies of PCB

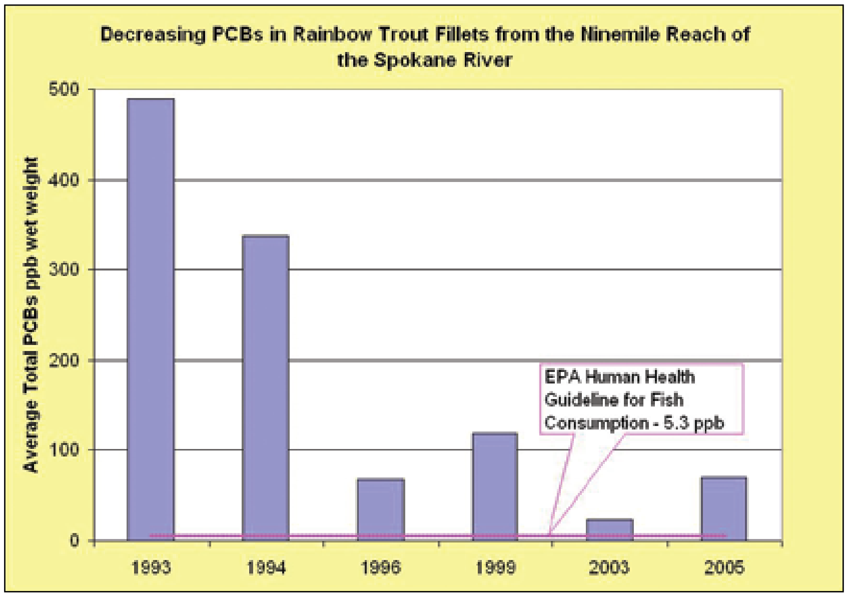


Figure 5.11: PCB levels in rainbow trout from throughout the Spokane River have declined due to hazardous waste cleanup efforts and a reduction in the amount of PCBs discharged in wastewater.

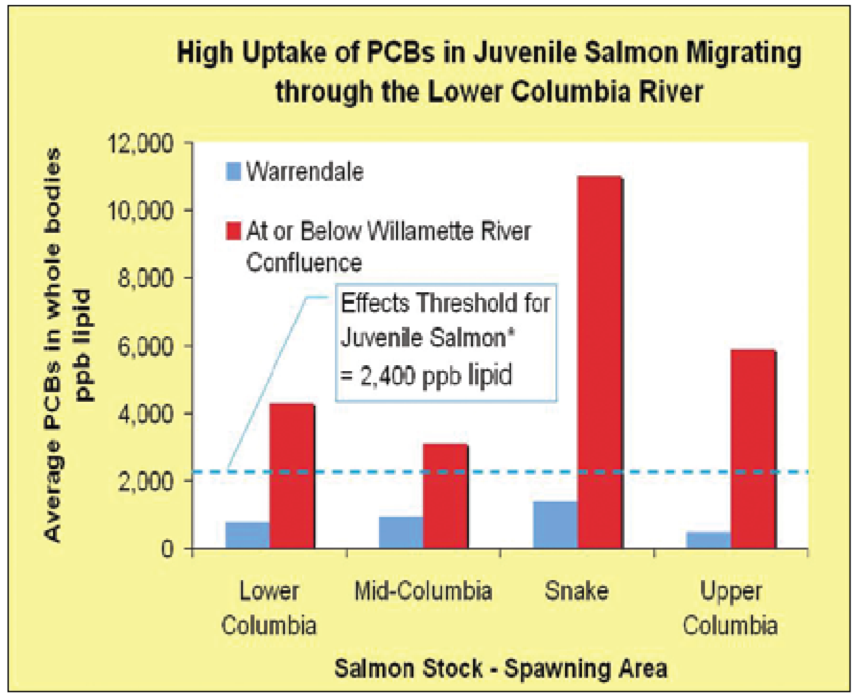


Figure 5.12: Migrating juvenile salmon, regardless of where they began their migration, consistently show higher levels of PCBs when captured in the Lower Columbia River below the Bonneville Dam.

concentrations in water also showed higher dissolved PCBs near the Portland/Vancouver area and downstream of the Willamette River than were found upstream near Bonneville Dam. [7,10] This suggests that there are significant sources of PCBs in the Lower Columbia River.

There are currently no data to indicate whether PCB levels in the mainstem of the Columbia River are increasing or decreasing. However, at some sites PCB concentrations in salmon were as high as or higher than those observed in juvenile salmon from industrial contamination sites in Puget Sound (Duwamish Waterway Superfund site in Seattle, Washington). At several sites in the Columbia River, salmon PCB concentrations were above levels at which juvenile salmon may be harmed (Figure 5.13).

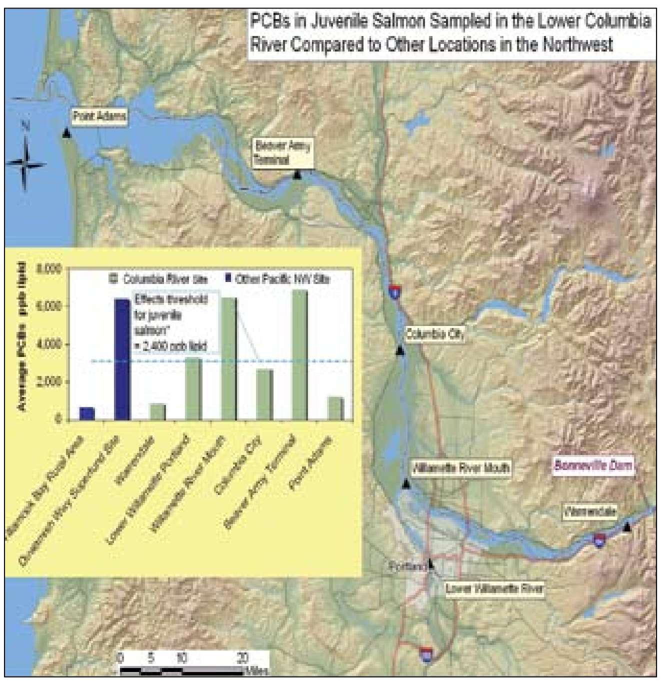


Figure 5.13: PCBs in juvenile salmon from several Lower Columbia River sites are similar to levels found in juvenile salmon at the Duwamish Waterway Superfund site in Seattle, Washington.

PCBs can also adversely affect the ability of mink and otter to reproduce. Mink are especially sensitive to the toxic effects of PCBs. Studies in the late 1970s showed that PCBs in mink from the Lower Columbia River were as high as those levels that are reported to cause total reproductive failure in female mink. [11]

Concentrations of PCBs in mink and otter have declined dramatically since the 1970s (Figure 5.14). [11,12,13] Despite these declines in contaminant concentrations and the presence of suitable habitat, mink remain scarce in the Lower Columbia. While there is a relatively dense otter population distributed throughout the Lower Columbia River, otters there have higher PCB concentrations compared to otters in other areas of Oregon and Washington. [14]

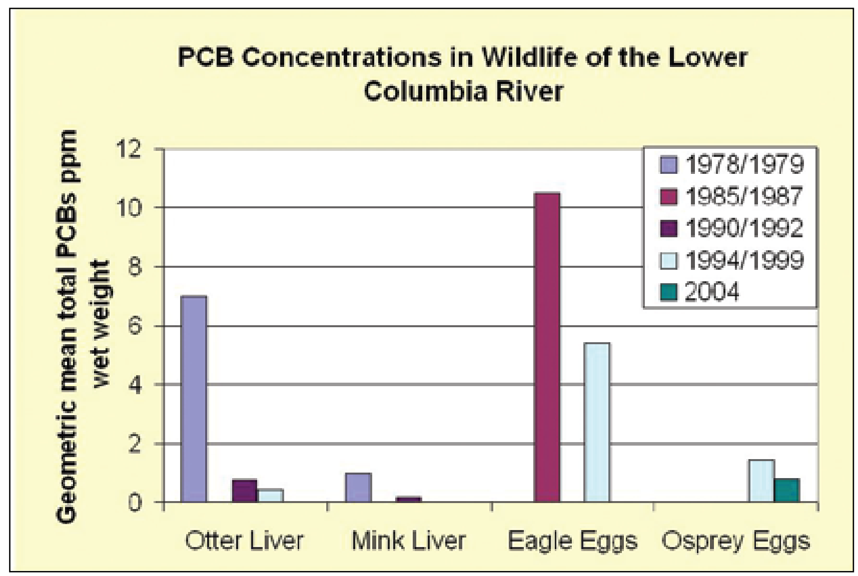


Figure 5.14: PCBs are decreasing in multiple fish-eating predators from the Lower Columbia River, due to decreased PCB use and contaminated site cleanup.

Like DDT, PCBs bioaccumulate in bald eagles and osprey. While PCB concentrations in eagle eggs from the Lower Columbia River were the highest recorded in the western United States in the 1980s, PCB levels are decreasing in both of these top predators (Figure 5.14). [15,16,17]

In 2005, U.S. Army Corps of Engineers (USACE) researchers used the Asian clam to describe distribution patterns of PCBs in the Lower Columbia River. [18] After analyzing samples from 36 stations, the researchers found distinctive spatial patterns related to the specific site from which the clams were collected. All clams collected had detectable levels of PCBs. Especially high levels of PCBs, ranging from 382 to 3,500 parts per billion (ppb), were found downstream of the Alcoa plant, a WADOE hazardous waste cleanup site (Figure 5.15) on the Washington side of the River.

Although "safe" levels for PCB consumption have not been formally established, the Clark County Health Office, State of Washington, recommends that seafood with PCB levels of up to 50 ppb should generally be eaten no more than two or three times per month.

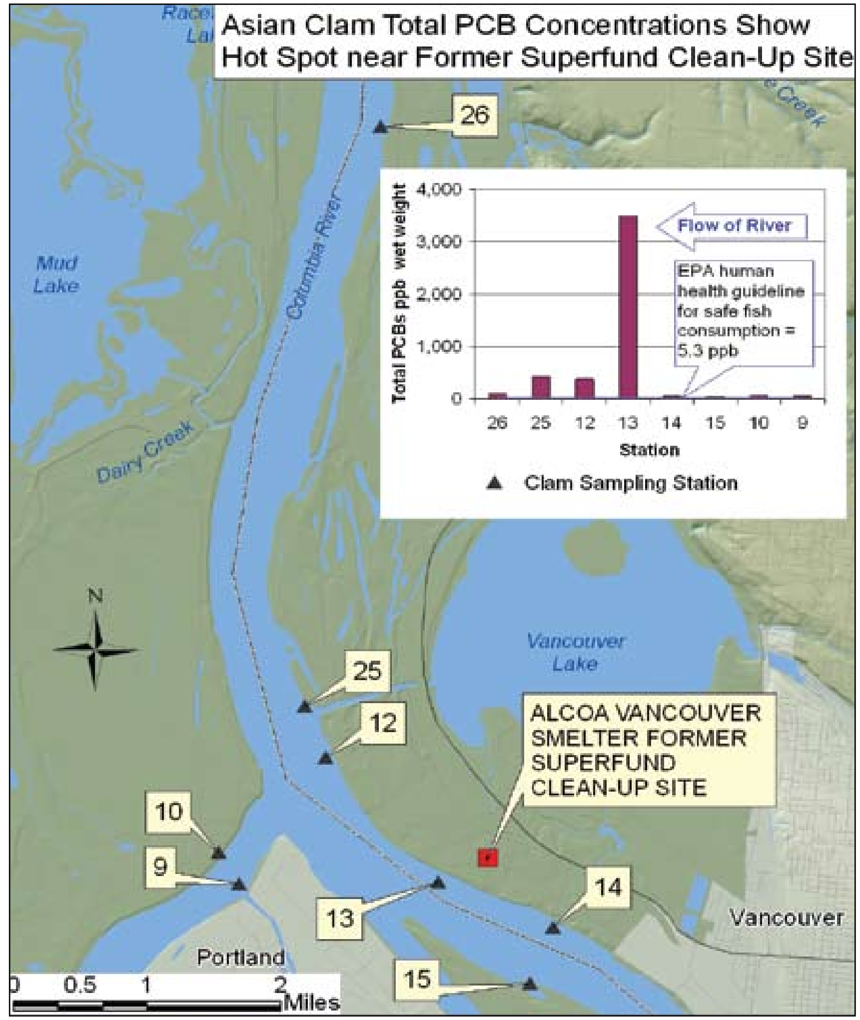


Figure 5.15: Clams collected in the Portland/Vancouver metropolitan area indicate PCB hot spots near the Alcoa plant, a WADOE hazardous waste cleanup site.

VISIT THE WEB	For more information on PCBs and the Alcoa cleanup, go to: http://www.ecy.wa.gov/programs/swfa/industrial/alum_alcoavan.htm.

PBDEs: Concern over Flame Retardants is Growing

PBDEs are a commonly used flame retardant. Many industries and states, including Washington, are phasing out products containing PBDEs. PBDEs are of concern because their levels have increased rapidly in soil, air, wildlife, and human tissue and breast milk.

The health effects of PBDEs have not been studied in people. Laboratory animal studies show neurological, behavioral, reproductive, and developmental effects and even cancer at very high doses.

PBDEs are in many everyday products

Since the 1960s, PBDEs have been added to plastics and fabrics to reduce the likelihood that these materials will catch fire or burn easily when exposed to flame or high heat. PBDEs are used in electrical appliances; TV sets; building materials; home, auto, and business upholstery; and rug and drapery textiles. They are released slowly to the environment from production, use, and disposal of these products. PBDEs, like PCBs, remain in the environment for a long time. PBDEs accumulate in all animals, but the concentrations continue to increase as an animal ages. However, unlike PCBs, EPA does not currently regulate PBDEs and only recently published a standard method for measuring PBDEs in environmental samples.

Figure 5.16 shows PBDE concentrations found in fish from U.S. waters in the Columbia River Basin.

Information on how PBDEs enter the environment is limited

While there is limited understanding on how PBDEs enter the environment, several studies have indicated that municipal wastewater may be a significant pathway. [1,2,3,4,5] PBDEs in dust and air are a direct pathway of exposure to people, but the importance of air and atmospheric deposition of PBDEs as a source to the Columbia River Basin is unknown. Runoff from municipal sewage sludge placed on land is also being examined as a possible source of PBDEs to surface water. [4,5,6] A study of PBDE contamination in the Canadian portion of the Columbia River found a correlation between high PBDE levels and areas where septic systems were concentrated near the River. [7]

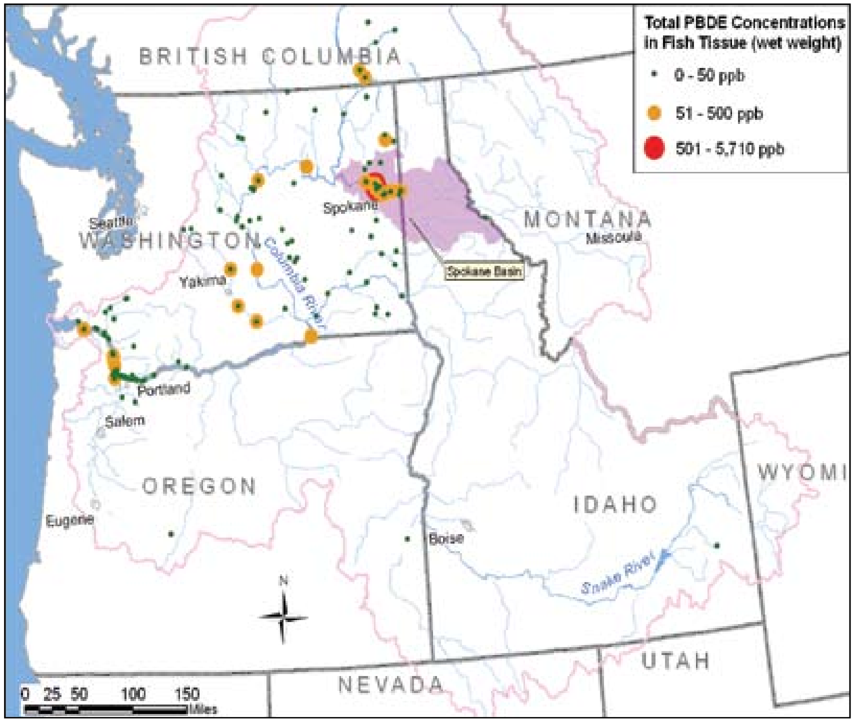


Figure 5.16: PBDEs are being detected and are increasing in fish in the Columbia River Basin. There is no information about PBDE levels in fish from waters that are unmarked on the map.

Levels of PBDEs in the Columbia River are increasing

In 1996, 1999, and 2005, the WADOE studied PBDE concentrations in sucker, mountain whitefish, and rainbow trout in the Spokane River (Figure 5.17). [8,9,10] PBDE levels in these species are increasing in most reaches of the Spokane River. The most dramatic increases were found in mountain whitefish downstream from the Spokane metropolitan area at Ninemile Reach.

Although relatively little PBDE data have been collected in the Columbia River Basin, the studies show that PBDEs are present and are increasing in the waters of the Columbia and several of its tributaries. [7] The studies further show that PBDEs are not only accumulating in larger fish [9] but are being taken up by juvenile salmon as well. [11]

In 2005, PBDEs were detected in all Asian clams collected from 36 stations throughout the Lower Columbia River. [12] The Lower Columbia appears to be an important source of PBDEs for salmon on their migration to the ocean based on the difference in PBDE concentrations in juvenile salmon above and below Bonneville Dam (Figure 5.18).

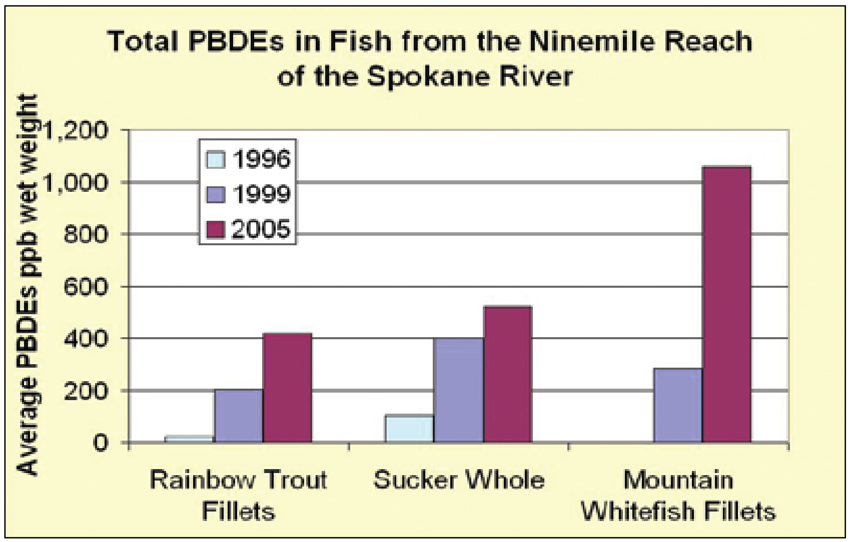


Figure 5.17: PBDE levels in Spokane River fish have increased since 1996.

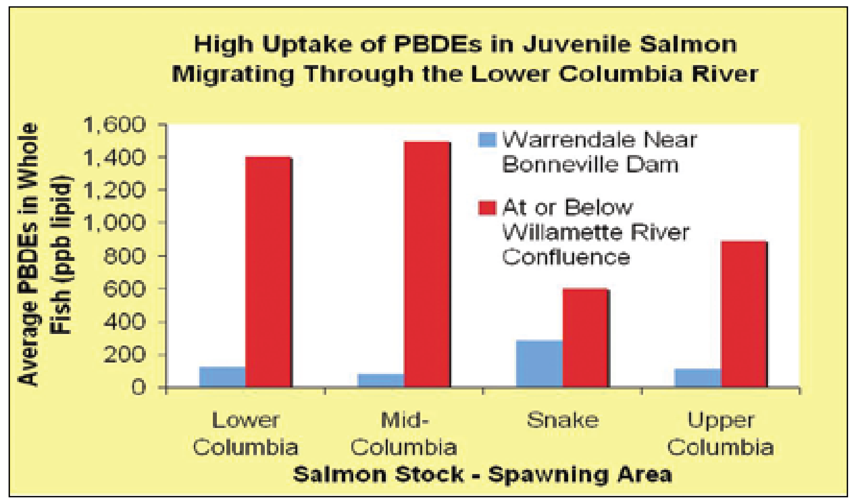


Figure 5.18: Migrating juvenile salmon, regardless of where they began their migration, consistently show higher levels of PBDEs when captured in the Lower Columbia River below the Bonneville Dam.

Summary of Status and Trends for Mercury, DDT, PCBs, and PBDEs

Table 5.2 summarizes the status of concentration levels for the four contaminants discussed in this report and their concentration trends where available.

Table 5.2. Summary of status and concentration trends for the selected indicator species

MERCURY		
Indicator Species	**Status**	**Concentration Trend over Time**
Resident fish - bass, whitefish, sucker, trout, walleye, northern pikeminnow	Increasing concentrations in fish tissue and bird eggs have been seen in the Snake and Willamette River Basins and other locations affected by regional sources compared to other areas within the Basin.	↑
Juvenile salmon		No Trend Data
Sturgeon		No Trend Data
Predatory birds – bald eagle and osprey		↑
Fish-eating mammals - mink and otter		No Trend Data
Sediment-dwelling shellfish - Asian clam		No Trend Data

Note: An upward-pointing red arrow indicates an increasing trend.

DDT AND BREAKDOWN PRODUCTS		
Indicator Species	**Status**	**Concentration Trend over Time**
Resident fish - bass, whitefish, sucker, trout, walleye, northern pikeminnow	The Columbia River Basin received some of the heaviest DDT loadings in the United States prior to the 1972 ban. Levels have decreased dramatically since the 1970s but are still above health effects limits for people, fish, and wildlife in many areas of the Basin.	↓
Juvenile salmon		No Trend Data
Sturgeon		No Trend Data
Predatory birds - bald eagle and osprey		↓
Fish-eating mammals - mink and otter		↓
Sediment-dwelling shellfish - Asian clam		No Trend Data

Note: A downward-pointing green arrow indicates a decreasing trend.

Table 5.2. Summary of status and concentration trends for the selected indicator species (cont)

PCBs

Indicator Species	Status	Concentration Trend over Time
Resident fish - bass, whitefish, sucker, trout, walleye, northern pikeminnow	PCB levels have generally declined since they were banned in the 1970s. Because PCBs are very stable and bioaccumulate in long- lived species and top predators, they are still a concern. Every state in the basin still has areas with fish consumption advisories and levels that exceed species effects levels. Sources are still being discovered.	↓
Juvenile salmon		No Trend Data
Sturgeon		No Trend Data
Predatory birds - bald eagle and osprey		↓
Fish-eating mammals - mink and otter		↓
Sediment-dwelling shellfish - Asian clam		No Trend Data

Note: An upward-pointing red arrow indicates a decreasing trend.

PBDEs

Indicator Species	Status	Concentration Trend over Time
Resident fish - bass, whitefish, sucker, trout, walleye, northern pikeminnow	In areas where data have been collected, levels of these chemicals are showing rapid increases. Though some studies have detected developmental and other impacts for humans and other species, there are currently no established effects levels for human or other species' health.	↑
Juvenile salmon		No Trend Data
Sturgeon		No Trend Data
Predatory birds – bald eagle and osprey		↑
Fish-eating mammals - mink and otter		No Trend Data
Sediment-dwelling shellfish - Asian clam		No Trend Data

Note: An upward-pointing red arrow indicates an increasing trend.